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THE INFLUENCE OF LABOUR MARKET DYNAMICS ON WAGE FORMATION

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ABSTRACT

This paper surveys empirical Phillips curve and wage curve models for The Netherlands. It provides a simple theoretical model with which an appropriate specification for Phillips curve and wage curve models can be derived, which reckons with labour market tightness and fits into a flow model of the labour market. We find that in particular the short term unemployment-vacancy ratio and flows from unemployment to employment affect the wage formation process.

AUTHORS' NOTE

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1. INTRODUCTION

The description of the wage formation process is crucial to models of the labour market. In most traditional macroeconomic policy models, wage formation is explicitly modelled in a wage equation, which includes the influence of some measure of unemployment on wages. The empirical relationship between wages and unemployment discovered by Phillips (1958) nowadays has a firm theoretical foundation. Phelps (1968) has shown how the Phillips curve effect can be derived from the behaviour of the firm, whereas in a newer tradition trade union behaviour has been shown to imply the so called wage curve effect (Oswald, 1982; Blanchflower and Oswald 1989; Graafland 1992). However, neither of these theoretical derivations of the specification of the wage equation prescribes that (some transformation of) the unemployment rate should act as a measure for labour market tightness. The theory allows for a much wider set of indicators. Traditional models of the labour market just have some measure of unemployment as explanatory variable in the wage equation, because it is the only indicator of labour market tightness that is endogenous in the model.

However, a new approach to modelling the labour market considers labour market dynamics by endogenising labour market flows (Blanchard and Diamond 1992). Most theoretical models of this flow approach to the labour market concentrate on equilibrium unemployment and therefore have an implicit description of wage formation. Yet, for an empirical model of labour market flows, an explicit modelling of wage formation by means of a wage equation is more appropriate when the labour market is not considered to be in equilibrium in each period. This is the case for the Netherlands in the last decades.

This paper investigates empirical specifications for the Dutch wage equation using alternative measures of labour market tightness, which are endogenous in a flow model of the labour market. The next section shortly reconsiders the theoretical foundation of the Phillips curve and the wage curve. Section 3 surveys the empirical wage equation for the Netherlands, whereas we present our own estimates of Phillips curve equations and wage curve equations for the Netherlands in section 4. The latter section also compares the size of the effect of labour market tightness on wage formation according to alternative indicators. Finally, section 5 concludes.

2. LABOUR MARKET DYNAMICS AND WAGE FORMATION

This section gives the theoretical background of the specification of a wage equation, which has an indicator of labour market tightness as explanatory variable. The Phillips curve specification is based on the theoretical model of Phelps (1968), where the firm is assumed to set the wages. The specification of the wage curve is described as outcome of a wage bargaining process. Cf. Graafland (1992).

2.1. The Phillips curve

We slightly adapt Phelps' (1968) theoretical foundation of the Phillips curve in order to obtain an appropriate specification for representing labour market dynamics and expectational behaviour. Starting point is a representative firm, which has a number of unfilled jobs. By offering a higher wage, compared to wages paid elsewhere, the firm will try to fill these vacancies. It is assumed that the supply of applicants for the vacancies will rise with total unemployment. When unemployment is high, the quit rate of current employees of the firm drops; it rises with the macro vacancy rate. The desired wage differential of the firm is then

$$(w_i^* - w)/w = f_1(ur,\ vr,\ vr_i), \tag{1}$$

where $f_{1ur} < 0$, $f_{1vr} > 0$, $f_{1vr_i} > 0$, w_i^* is the wage rate the i-th firm wishes to pay, w is the average wage rate of all firms, ur is the macro unemployment rate, vr is the macro vacancy rate, vr_i is the number of unfilled jobs of the i-th firm.

Phelps assumes that all firms behave much alike and hence the average wage differential will be a function of the unemployment rate and the aggregate vacancy rate.

$$(w^* - w)/w = f_2(ur,\ vr), \tag{2}$$

where $f_{2ur} < 0$, $f_{2vr} > 0$ and w^* is the average wage rate the firms are willing to pay.

Next it is postulated that

$$\overset{\circ}{w} = \lambda\,[(w^{*} - w)/w], \quad 0 < \lambda < 1, \tag{3}$$

where $^{\circ}$ implies the percentage change of the variable involved. This equation assumes that each firm expects the wage rate paid by others to be constant during the duration of the wage negotiated. Hence, the average wage rate will rise (fall) if all firms want to pay a wage higher (lower) than other firms. It is assumed that firms in the aggregate adjust their wages only gradually towards the average desired differential, represented by the value of the constant λ. The gradualness might come from the administrative and psychic costs of changing wage rates that causes wages to be changed only intermittently or periodically. If these wage negotiations are staggered across firms or workers, the average wage rate will move more or less smoothly. In addition, the uncertainty of the firm whether the "desired" wage differential would have the desired effect on turnover costs will induce a cautious, gradual response in the individual firm's wage decision.

Moreover, in order to guess the employment effects of its wage decision, the firm will want to forecast wage changes elsewhere. This assumption implies an expectations augmented Phillips curve:

$$\overset{\circ}{w} = \overset{\circ}{w}^{e} + \lambda\,[(w^{*} - w)/w] = \overset{\circ}{w}^{e} + \lambda f_2(ur, vr) = \overset{\circ}{w}^{e} + f_3(ur, vr), \tag{4}$$

where $\overset{\circ}{w}^{e}$ is the expected percentage wage rate change, which Phelps assumes to be generated by adaptive expectations.

In this paper, we assume a different expectations formation process for the wage rate. The expected wage rate is specified as a function of lagged wages (w_{-1}), consumers and producers prices (p_c and p_y), labour productivity (h) and taxes and social premiums paid by employers and employees (tp). Our expectations augmented Phillips curve now becomes

$$\overset{\circ}{w} = f_4(\overset{\circ}{w}_{-1},\ \overset{\circ}{p}_c,\ \overset{\circ}{p}_y,\ \overset{\circ}{h},\ \overset{\circ}{tp}) + f_3(ur,\ vr), \tag{5}$$

where $f_{4p_c} > 0$, $f_{4p_y} < 0$, $f_{4h} > 0$, $f_{4tp} > 0$.

Equation (5) is the starting point of our specification of the wage equation, which reckons with labour market dynamics, in the wage formation process. Therefore we will consider in more detail the function representing labour market behaviour f_3. First, we can neglect the effect of vacancies. As a matter of fact, Phelps assumed that the vacancy rate is related to the unemployment rate and to the percentage change in the unemployment rate. Obviously, this simplifying assumption was made in order to arrive at the standard specification of the Phillips curve with unemployment as indicator of labour market tightness. However, our summary of Phelps' arguments make it clear that this theoretical foundation of the wage equation allows for a much wider set of indicators of labour market tightness. So, we will shortly review how some of these indicators fit into this theoretical setup. A first alternative, which is very much in line with Phelps' original theory, is to consider the vacancy rate as the sole indicator in f_3, thereby neglecting the effect of unemployment. This is a sort of extreme version of the insider-outsider theory, developed by, e.g., Lindbeck and Snower (1986). Another possibility is to have the unemployment-vacancy (UV) ratio as determinant of wage formation. This ratio can be considered as a measure of the flexibility on the labour market. High unemployment and few vacancies imply an inefficiently working labour market.

The insider-outsider theory asserts that only short-run unemployed are of interest for the wage decisions of firms. Firms are less inclined to hire long-term unemployed. Long-term unemployed loose their skills and the ability to work. Moreover, they become discouraged to search for new jobs. Hence, in this view, the supply of applicants for unfilled jobs, as in (1), does not depend on total unemployment, but on the short-run unemployment only. One way to represent this is to take the logarithm of the unemployment rate. In periods of high unemployment, and hence high long-term unemployment, this implies that less importance is attached to the effect of unemployment on wages compared to periods of low unemployment, i.e., relatively more short term unemployed. The same argument applies to the UV ratio as representing labour market dynamics. On the other hand, in the context of the insider-outsider theory, it might be more appropriate to just take the number of unemployed with a duration of less than twelve months as a proxy for short-term unemployment.

We can also interpret the function f_3 of equation (5) in a flow context. Cf. Blanchard and Diamond (1992). In this interpretation, we stress the importance of the flow of persons moving from the reservoir of the employed to the reservoir of the unemployed, and *vice versa*, on the wage decisions of firms. A high inflow into unemployment implies an increase in the supply of applicants for possible unfilled jobs and hence has a depressing effect on the wage rate changes. High inflow into employment has the *opposite* effect. Now equation (5) becomes

$$\mathring{w} = f_4(\mathring{w}_{-1}, \mathring{p}_c, \mathring{p}_y, \mathring{h}, t\mathring{p}) + f_5(F_{ue}, F_{eu}), \tag{6}$$

where F_{ue} and F_{eu} are the flow of persons from unemployment to employment and *vice versa*, respectively.

We still have to specify the functional forms f_3, f_4, f_5 in (5) and (6). For reasons of convenience, we assume simple linear models with a flexible specification, allowing for a number of distributed lags on all explanatory variables. Hence, the operational form of the Phillips curve models we are going to estimate is

$$\phi(L)\mathring{w}_t = \mu + \alpha_1(L)\mathring{p}_{ct} + \alpha_2(L)\mathring{p}_{yt} + \alpha_3(L)\mathring{h}_t + \alpha_4(L)t\mathring{p}_t + \alpha_5(L)X_t + \varepsilon_t \tag{7}$$

where $\Phi(L) = 1 - \Sigma_{j=1}^{p}\phi_j L^j$, $\alpha_i(L) = \Sigma_{j=0}^{r}\alpha_{ij}L^j$, X_t is the vector of variables that represent labour market tension and we endogenise to models of labour market dynamics. They may consist of, e.g., the (short-term) unemployment rate, vacancy rate, (short-term) unemployment-vacancy ratio and possible flows out of and into unemployment. Finally, ε_t is a white noise error process.

2.2. The wage curve

An alternative way to specify the wage formation process originates from Sargan (1964). This tradition derives the wage level from a microeconomic theory of wage bargaining. See, e.g., Layard and Nickell (1986), Blanchflower and Oswald (1989), Graafland (1992). The outcome of such a bargaining process between a representative employee and employer is represented by a generalised Nash bargaining solution

$$\max_{w}.\ \alpha\log[u(w)-\bar{u}] + (1-\alpha)\log[\pi(w)-\bar{\pi}], \tag{8}$$

where $u'(w)>0$, $\pi'(w)<0$, $0<\alpha<1$, $u(w)>\bar{u}$, $\pi(w)>\bar{\pi}$ and u and π are the utility functions of the employee and employer, respectively, which depend on wages. The workers' utility is a positive function of the wages, while employers' utility is negatively related to the wages. The utility levels $\bar{u}$ and $\bar{\pi}$ are the threat point of the worker and employer, respectively, and represent their utility obtained during a breakdown in the bargaining process, α is a parameter representing the relative bargaining strength of the worker.

Labour market dynamics enter into this model through the assumption that bargaining power is related to internal labour market pressures, like the vacancy rate, and external pressures, like (short-term) unemployment. These two can be joined in the UV ratio. Also the two approximations of flows on the labour market introduced above, are capable of representing such pressures.

The crucial difference of the wage curve resulting from the bargaining theory in comparison with the Phillips curve is that here the labour market variables affect the wage level, not the wage growth. There is a stable relation between the wage level and the variables representing labour market dynamics. The location of the wage curve will depend on the other exogenous variables in the wage negotiation process. We assume those variables to be the same as the exogenous variables of the Phillips curve specification, i.e., consumer prices (p_c), producer prices (p_y), labour productivity (h) and taxes and social premiums (tp). Hence, in log-linear form our wage curve is

$$\log w_t = \mu + \beta_1\log p_{ct} + \beta_2\log p_{yt} + \beta_3\log h_t + \beta_4\log tp_t + \beta_5 X_t + \varepsilon_{1t}, \tag{9}$$

where X_t represents the variables of labour market dynamics, be it (short-term) unemployment, vacancies, UV ratio, or the flows from employment to unemployment and *vice versa* and ε_{1t} is a stationary error process. The latter assumption implies that when all variables in (9) are nonstationary, in the sense that they contain a unit root, these series may be cointegrated. In that case equation (9) turns into an error-correction specification. Again assuming a flexibly specified autoregressive distributed lag model, we find

$$\varphi(L)\Delta\log w_t = \mu_0 + \beta_1(L)\Delta\log p_{ct} + \beta_2(L)\Delta\log p_{yt} + \beta_3(L)\Delta\log h_t +$$

$$\beta_4(L)\Delta\log tp_t + \boldsymbol{\beta}_5'(L)\Delta \boldsymbol{X}_t - \tag{10}$$

$$\gamma[\log w + \theta_1\log p_c + \theta_2\log p_y + \theta_3\log h + \theta_4\log tp + \boldsymbol{\theta}_5\boldsymbol{X}]_{t-1} + \varepsilon_{2t}$$

where $\varphi(L) = 1 - \Sigma_{j=1}^{p}\varphi_j L^j$, $\beta_i(L) = \Sigma_{j=1}^{r}\beta_{ij}L^j$ and ε_{2t} is a white noise error process.

Note that this complication of moving from the specification in levels to an error correction specification is assumed to occur only with a wage curve specification. This is because the variables in (9) are integrated of order 1 (I(1)). On the other hand, the time series variables in the Phillips curve specification (7) are already specified as I(1), as these variables are denoted in percentage differences, which can be approximated by the first difference of the logarithm of the levels of these variables. Yet, in case the variables in (7) were I(1), the wage equation containing the Phillips curve effect could be specified in an error-correction form. This would imply that the level of the variables in (7) and therefore the variables in (9) are I(2).

Today labour economists tend to prefer the bargaining theory to Phelps' theory of wage setting behaviour by the firm, for the specification of the wage equation. That is why, from a theoretical perspective, there is some preference to have a wage curve effect specified in the wage equation rather than a Phillips curve effect. However, Knoester and van der Windt (1987) have derived a Phillips curve specification as in (7), which is based on wage bargaining between the unions and the employers' organizations. In their model, unions and employers' organizations bargain over wage growth. The wage outcome is a weighted average of wage growth claims of unions and wage growth offers of employers. Labour market dynamics is introduced by the bargaining power of both parties. The bargaining power of the union is assumed to be negatively related to the level of (short-term) unemployment. As argued above it may be positively related to the vacancy rate. Bargaining power can also be interpreted in terms of the UV ratio or the flow variables between the stocks of employed and unemployed. Furthermore, the other driving variables for the wage growth rate are the same as in (7). Thus, this theory yields a specification that is observational equivalent with the one of Phelps (1968).

3. WAGE EQUATIONS FOR THE NETHERLANDS

This section surveys empirical wage equations for the Netherlands. In most large macroeconomic models in the Netherlands, the wage equation contains a Phillips curve effect as indicator of labour market tightness. The rationale for this inclusion goes back to the seminal articles of Phillips (1958) and Lipsey (1960).

As derived in the previous section, a standard Phillips curve model relates nominal wage growth to the level of unemployment and a number of other explanatory variables, like (consumer) price inflation, growth of labour productivity and growth of taxes and social premiums paid by employers and employees. In some cases it is also argued to include the growth rate of unemployment as an additional explanatory variable to take account of a possible negative relation between the wage level and the level of unemployment. This phenomenon is referred to as the Lipsey-effect. Table I presents the estimation results of some recent Phillips curve models for the Netherlands. In addition to the symbols introduced previously, we have $\mathring{tpw}$ and $\mathring{tpl}$ the total taxes and social premiums paid by employers and employees, respectively. Wage curve models for the Netherlands have only recently been estimated. Table II gives some estimation results for wage curve models for the Netherlands.

There is some convergency of the empirical evidence in tables I and II. First, in both the Phillips curve and the wage curve models, price increases are fully passed on to the wages, as in both tables the elasticity of prices to wages is unity. Second, in most models the same applies to the labour productivity; in many models there is a unit, or at least a near-unit, elasticity between labour productivity and wages. Hence, the wage space, which is defined as the sum of price inflation and labour productivity, is completely filled. This can also be explained on institutional grounds for the Netherlands, as was argued by Den Butter and Van de Wijngaert (1992),

TABLE I. Phillips curve models for the Netherlands.

$$\overset{\circ}{w} = \alpha_0 + \alpha_1 \overset{\circ}{p}_c + \alpha_2 \overset{\circ}{h} + \alpha_3 tp\overset{\circ}{w} + \alpha_4 tp\overset{\circ}{l} + \alpha_5 ur + \alpha_6 \Delta ur$$

	α_1	α_2	α_3	α_4	α_5	α_6
Knoester (1983)	1.00	1.00	0.25	0.85	-1.68	-5.62
Groene *et al.* (1984)	1.00	0.92	1.00	1.00	-0.25	-
Verbruggen (1985)	1.00	0.55	1.04		-1.52	-
Knoester *et al* (1987)*	1.00	0.69	1.15		0.78[1]	-
v.d.Berg *et al.* (1988)	1.00	1.09	0.43	0.90	3.23[2]	-
Kuipers *et al.* (1990)	1.00	1.00	0.86	0.43	6.64[1]	
Fase *et al.* (1990)	1.05	0.85	0.10	0.69	-0.17	
Keus *et al.* (1991)	1.00	0.81	0.75	0.57	-0.12	-1.14
Houweling *et al.* (1992)	1.00	0.65	0.80	0.36	-0.13	-1.03

[1] $ur = 1/u$; [2] $ur = \log(1/u)$.
* no distinction between taxes and social premiums paid by employers and employees.

TABLE II. Wage curve models for the Netherlands.[1]

	Graafland					Lever	Mulder
	1990[2]	1990a	1990b	1991	1992	1991	1990
labour market variables:							
unemployment rate (ur)[3]	-	-	-	-	-1.19	-1.49	-0.12
short-term ur	-2.90	-	-0.64	-	-	-	-
long-term ur	-1.77	-0.49	-1.37	-0.63	-	-	-
long-term ur/ur[4]	-	-0.15	-	-0.10	-	-	-
lay-off rate	-	-2.01	-	-1.20	-	-	-
vacancy rate		1.32		1.57			
other variables:							
consumer price	1.00	0.46	-0.06	0.65	0.48	0.78	1.00
value added price	-	0.54	1.06	0.35	0.52	0.22	-
labour productivity	1.09	0.83	1.01	0.85	0.71	1.00	0.95
average tax rate	0.77	0.50	0.29				0.63
marginal tax rate	-	-	-	-0.11	-	-	-
employers' tax rate[5]	-	-	-	0.91	-1.00	0.76	-
employees' tax rate[5]	-	-	-	0.40	-0.57	0.50	-
replacement ratio[6]	-	0.32	0.19	0.27	0.31	0.17	

[1] all coefficients have been reduced to their long-run values to make them comparable; [2] Graafland and Huizinga (1990); [3] Lever (1991) uses $-\log(1-u)$ and Mulder (1990) $\log u$; [4] ratio of long-term and total unemployment; [5] $\log(1-tax)$; [6] ratio of net government assistance and net average wages.

4. EMPIRICAL RESULTS

This section presents the estimation and test results for specifications (7) and (9) or (10) using quarterly data for the Netherlands. Our modelling strategy is to move from a general to a specific specification, where the ultimately chosen model should still fulfill some essential statistical properties, like absence of residual autocorrelation and heteroskedasticity and normally distributed residuals. We start with the results for the Phillips curve specification and next give the results for the wage curve. The sample period is 1970.I to 1991.IV. In order to give an impression of the adequacy of the selected specifications, we also present the correlation coefficient R^2, the residual standard error $S.E.$ and a number of misspecification tests: the LM test of Godfrey (1979) on absence of residual autocorrelation, the normality test of Jarque and Bera (1980) and the ARCH test of Engle (1982).

4.1. The Phillips curve

Table III presents the estimation and test results of the Phillips curve for the Netherlands. Based on previous research on the Dutch Phillips curve, in line with the purpose of our research and following the arguments of Den Butter and Van de Wijngaert (1992) that the wage space is completely filled up in the long run, we have set the coefficients of consumers price inflation and growth of labour productivity equal to one. Simplification of (7) indicated that we should also include the lagged growth rates of wages, consumer prices and producer prices and in most cases, the change in taxes and social premiums lagged three periods.

The specifications differ only in the inclusion of the variables representing labour market dynamics. We have estimated models with the following indicators of labour market tightness:

the unemployment rate (***ur***),

the short-term unemployment rate (***stur***),

the vacancy rate (***vr***),

the UV ratio (***uv***),

the short-term unemployment-vacancy ratio (***stuv***) the flow of unemployment to employment as percentage of the labour force (f_{ue})

the flow of employment to unemployment as percentage of the labour force (f_{eu}).

f_{ue} is the flow of filled vacancies as percentage of the labour force and for f_{eu} is flow of persons moving from employment into 'firing' unemployment, as percentage of the labour force.

First, our results seem to confirm the premise of the insider-outsider theory that short-term unemployed matter more in the wage determination process than long-term unemployed, as the impact of the short-term unemployment is larger than the impact of the total unemployment. Moreover, vacancies and the UV ratio exert about the same influence on wage changes, as measured by their explanatory power. Again confirming the insider-outsider theory, the effect of the short-term unemployment-vacancy ratio is larger than that of the actual UV ratio. Finally, the two actual flow variables imply that the inflow into unemployment is insignificant and that only the flow of filled vacancies (f_{ue}) influences the wage rate change.

Note that all specifications of table III are statistically adequate, as none of the diagnostic tests is significant at any reasonable significance level. Which specification do we prefer for inclusion into a model which fully endogenises labour market dynamics? First, based on theoretical considerations, it is in particular the short-term unemployment that influences the growth rate of the wages. An increase in short-term unemployed implies an increase for the firm in the stock of persons able to fulfill the vacancies. The long-term unemployed have lost their working skills and motivation and may no longer be available to fill the vacancies and hence no longer exert a dampening effect on wage changes. On the other hand, also vacancies influence wage changes, as our theory of section 3.1 claims. Since a specification in which both variables appear separately, yields insignificant values for the parameter of the vacancies, it therefore seems natural to prefer the specification with the combination: the short-term unemployment-vacancy ratio (***stuv***).

Second, if we want to take account of actual flows on the labour market to represent labour market dynamics, we should prefer the specification with the flows to and from employment and unemployment. Hence, the natural specification to prefer is the specification with the flow of unemployment to employment as indicator of labour market tightness.

4.2. The wage curve

The estimation and test results of the wage curve specification for the Netherlands, using quarterly data, are given in table V. Apart from the labour market variables that were used in the previous section, we will now also include another measure of labour market dynamics, namely the index of labour market mismatch (*mm*), introduced by Layard and Nickell (1986). This is the absolute change of the proportion of employees in the production sector. The idea is that this index measures the rate at which jobs shift from the production sector (a leading sector, as far as wage rate determination is concerned; cf. Graafland and Verbruggen, 1993) to the rest of the economy, leaving pockets of unemployment in the declining sector(s).

As discussed in the previous section, we have to test on the presence of unit roots in the time series data in order to distinguish between equation (9) and (10). In table IV we give the results of the unit root tests of Dickey and Fuller (1981), Phillips (1987) and Phillips and Perron (1988). None of the variables shows solid evidence of stationary, hence we have to start with equation (10) and test on the presence of a significant cointegration relation. We will apply the cointegration test of Boswijk (1992). In all cases a significant cointegration relation, as presented in table V, cannot be rejected.

Just as with the Phillips curve specification, we assume that the level of the wage space, i.e., the sum of consumer price level and level of the labour productivity, is completely filled in the long run. Thus, the coefficients of consumer prices and labour productivity are set to unity in the long run equilibrium part of the model. In order to avoid serial autocorrelation and in order to allow for partial adjustment in the wage formation process, we also included lags of the wage rate growth and lagged values of the other explanatory variables in (10).

In the specification of the wage curve, we will again include *ur*, *stur*, *uv*, *stuv*, f_{ue} and also the mismatch variable *mm*, as an alternative measure of labour market tension. Even though the model with *mm* cannot be rejected by the misspecification tests, this variable does not seem to have a very strong effect on the wage rate. The unemployment rate (ur) and the unemployment-vacancy ratio (uv), are particularly strong explanatory variables. The same holds for the flow of unemployment to employment, f_{ue}.

Hence, as with the Phillips curve models, the specifications we prefer are based on theoretical considerations and statistical properties of the models, given the fact that the wage curve equation is to be included into a flow model of the Dutch labour market. This specification contains both the unemployment-vacancy ratio (uv) and the flow of unemployment to employment as percentage of the labour force (f_{ue}). See table V, the last column.

4.3 Comparison

Our preference for the selected specifications of the wage curve and the Phillips curve is based on both theoretical arguments and on the explanatory power of the variable representing labour market tightness. In order to compare the size of the effects of labour market tightness on wage formation according to the alternative specifications, we have conducted an impulse response analysis. For a number of equations from tables III and V, we have calculated the short run and long run effects of a shock to the alternative indicator of labour market tightness on wage changes, which first corresponds to an permanent increase in unemployment of 100,000 persons per year. The second shock we consider is a permanent decrease in the number of vacancies.

In fact the unemployment shock is modelled as an increase in short-term unemployed of 25,000 in each quarter over the period 1987.I-1987.IV. This implies that in 1988 short-term unemployment falls by 25,000 persons each consecutive quarter, since in 1988.I, the additional short-term unemployed from 1987.I have become long-term unemployed or have found a job. The same applies to the other quarters of 1987, until the old level of short-term unemployment is reached in 1988.IV. Note that this assumption implies that the change in unemployment is 25,000 persons higher in 1987, than would otherwise have been the case. We assume this amount to be evenly spread among the flows into and out of unemployment. Hence, F_{ue} falls with 12,500 persons from 1987.I to 1987.IV. The impulse responses for a number of quarters are listed in table VI, where the columns mentioned in that table refer to the number of the column of table III or table V, respectively.

We first conduct this impulse response analysis to the Phillips curve of the second column of table III, which contains the short-term unemployment rate as indicator of labour market tightness. Due to the increase in short-term unemployment, the growth of the wage rate falls, reaching its trough after six quarters and then moving back to the original growth level. Notice that this decrease in wage growth is quite substantial for some quarters. The Phillips curve in the fifth column of table III, contains the short-term unemployment-vacancy ratio as indicator of labour market tightness. The size of the response to the increase in unemployment is now much smaller, reaching its trough after five quarters. Of course, the effect is dampened by the fact that short-term unemployment is divided by the vacancies, which remain unchanged. In the long run, the variables in this model return to their original levels, so the response is zero. The sixth column of table III, presents the Phillips curve with the flow variables as indicators of labour market tightness. The size of the responses are more in line with those of the previous model. In the long run f_{ue} is slightly lower as the labour force has increased with 100,000 persons and hence the wage growth is also lower.

The responses of the wage curve of the first column of table V, which has unemployment and the first difference of unemployment as indicators of labour market tightness, are also considerable in size for the third to the sixth quarter. The wage curve in column five has the change of the flow of unemployment to employment (Δf_{ue}) and the short-term unemployment-vacancy ratio (*stuv*) as indicators of labour market tightness. Its response is very similar to that of the model in the sixth column of table V, which has Δf_{ue} and the unemployment-vacancy ratio (*uv*) as indicators of labour market tightness. There is a large drop in wage growth in the third quarter, because then Δf_{ue} becomes operative, and a rise in wage growth in the seventh quarter, as then f_{ue} returns to its original level. In the model of column 5, the long-term effect is virtually zero, as both F_{ue} and the short-term unemployment return to their original levels. For the model of column 6, the long-term effect is larger, as here *uv* permanently takes on a higher value.

Next, we turn to a permanent decrease in the vacancies of 12,500 each quarter of 1987. From 1988 onwards the number of vacancies is thus 50,000 lower. This implies that the change in vacancies is 12,500 lower for all quarters of 1987, hence the difference between inflow and outflow of vacancies is -12,500 for each quarter in 1987. For convenience sake, we assume this amount to be evenly spread between inflow and outflow, thus for 1987.I to 1987.IV, F_{ue}, the flow of filled vacancies, increases with 6,250. The effect of this shock to the Phillips curve and wage curve models mentioned before are given in table VII.

Since in standard Phillips and wage curves, vacancies are not considered as measure of labour market tightness, a shock to the number of vacancies will have no effect on these models. A decrease in vacancies implies that firms are inclined to pay lower wages than would otherwise have been the case. This is shown by the response of the Phillips curve in the fifth column of table III to the shock in the vacancies. See table VII. The Phillips curve of the final column of table III has F_{ue} as only measure of labour market tightness, which is also affected by the vacancy shock, as we have seen. Since the decrease in vacancies over 1987 implies a increase in the flow of filled vacancies, the effect of this specification is confined to 1987. The wage rate rises slightly by 0.04 percentage points over four quarters. It shows, however, that this specification is not very adequate in case of a change in vacancies, as it only reckons with the decrease in the flow of unemployment into employment, associated with that vacancy change.

For the wage curve specifications of columns five and six of table V, we find a similar pattern in the response, reaching a trough after six quarters for both models. In 1987.III, Δf_{uet-2} becomes operative causing the initial wage rate decrease to become less. Its influence ends in 1988.2, causing an additional drop in the wage rate change. The troughs of this quarter can be quite substantial. Afterwards, the response starts fluctuating around a new, lower, equilibrium level.

All in all, our simulations show that the measured effect of labour market tightness, represented by an increase in unemployment, on wage formation is smaller, when we explicitly reckon with various aspects of labour market dynamics, as compared to the traditional use of unemployment representing the wage curve or Phillips curve effect in the wage equation. However, when we look at a decrease of vacancies as indicator of labour market tightness, the standard Phillips and wage curve models do not show any reaction. Our specifications that do take account of labour market dynamics are then more realistic. Notice that we have only looked at the effect in the wage equation in isolation of the rest of the model. If the wage equation were to be included into a fully-fledged model of labour market flows, second order effects could magnify the Phillips curve or wage curve effects modelled according to the alternative indicators.

5. CONCLUDING REMARKS

This paper empirically investigates the influence of labour market dynamics on wage formation. Traditionally wage equations include either a Phillips curve or a wage curve effect using unemployment as an indicator of labour market tightness. The theoretical foundation of the Phillips curve, which is based on wage setting behaviour of the firm, and of the wage curve, which is based on bargaining between employers and employees, leaves scope for a wider set of indicators of labour market tightness than unemployment. If the wage equation is to be included in a traditional macroeconomic model, which does not reckon with labour market dynamics and which has (short-term) unemployment as the sole indicator of labour market tightness, it is obvious that (some transformation of) unemployment is to be included as explanatory variable in the wage equation. On the other hand, when the wage equation forms a part of a model of labour market flows, a number of alternative indicators, which are endogenous in the model, should be considered.

Our empirical estimates for The Netherlands show that some of these alternative indicators qualify for inclusion into the wage equation indeed. These are the short-term unemployment-vacancy ratio and the flow of unemployment to employment as alternatives in the Phillips curve specification of the wage equation and both the unemployment-vacancy ratio and the flow from unemployment to employment in the wage curve version of the equation. Impulse response simulations show that not only unemployment, but also vacancies as indicator of labour market tightness influence the wage rate, as opposed to standard Phillips and wage curves.

TABLE III
Estimation and test results of Phillips curve equations for the Netherlands, with different measures of labour market tension.
Dependent variable: $\Delta \log w_t$

constant	-.004	.004	-.019	-.006	-.007	-.028
	(-0.793)	(0.825)	(-5.680)	(-1.929)	(-2.219)	(-5.467)
$\Delta \log p_{ct}$	1.00	1.00	1.00	1.00	1.00	1.00
$\Delta \log h_t$	1.00	1.00	1.00	1.00	1.00	1.00
$\Delta \log w_{t-1}$	-.340	-.364	-.307	-.295	-.289	-.316
	(-3.368)	(-3.612)	(-3.146)	(-3.095)	(-3.096)	(-3.324)
$\Delta \log p_{ct-1}$	.520	.475	.587	.522	.573	.700
	(2.675)	(2.404)	(3.021)	(2.633)	(2.976)	(3.722)
$\Delta \log h_{t-3}$	1.09					1.30
	(2.152)					(2.736)
$\Delta \log p_{yt-1}$	-.355	-.380	-.382	-.378	-.378	-.324
	(-3.245)	(-3.436)	(-3.385)	(-3.368)	(-3.392)	(-3.018)
$\Delta \log tp_{t-3}$		.085	.088	.114	.113	
		(2.003)	(1.960)	(2.340)	(2.385)	
$stur_{t-2}$	-.162	-.267				
	(-2.216)	(-3.487)				
vr_{t-2}			.480			
			(2.966)			
uv_{t-1}(*1000)				-.448		
				(-3.095)		
$stuv_{t-1}$(*1000)					-.768	
					(-3.280)	
f_{uet-1}						.403
						(2.960)
R^2	.645	.647	.633	.636	.641	.761
S.E.	.0104	.0104	.0106	.0106	.0105	.0102
T	84	85	85	85	85	85
$F_{AR}(1,75)$	1.00	.754	1.26	.705	.718	.652
$F_{AR}(5,71)$	.772	.592	.708	.401	.439	.791
$\chi^2_N(2)$	.443	.915	.250	2.00	1.65	.733
$F_{ARCH}(1,84)$	.046	.203	.043	1.00	.664	.001
$F_{ARCH}(5,80)$	.610	.391	.582	.420	.385	.670

F_{AR} is the autocorrelation test of Godfrey (1979), χ^2_N is the Jarque-Bera test on normality and F_{ARCH} is Engle's ARCH test. These statistics indicate the distribution under the null hypothesis and the degrees of freedom are between parentheses. T is the number of observations used for estimation and testing.

TABLE IV.
Unit root test results

	$ADF(k)^{\dagger}$		*Phillips* (1987)	*Phillips-Perron* (1988)
$\log w_t$	-3.123^{*}	(k=4)	0.272^{*}	-2.607^{*}
$\log p_{ct}$	-3.042^{*}	(k=2)	0.217^{*}	-1.801^{*}
$\log p_{yt}$	-2.710^{*}	(k=1)	0.181^{*}	-2.112^{*}
$\log h_t$	-3.820	(k=3)	0.056^{*}	-2.370^{*}
$\log tp_t$	-2.360^{*}	(k=3)	-0.297^{*}	-3.174^{*}
ur_t	-1.462^{*}	(k=9)	0.384^{*}	-1.845^{*}
$stur_t$	-1.763^{*}	(k=9)	0.092^{*}	-3.538^{*}
vr_t	-1.978^{*}	(k=7)	-2.622^{*}	-6.955^{*}
uv_t	-2.317^{*}	(k=5)	-1.991^{*}	-4.009^{*}
$stuv_t$	-2.511^{*}	(k=5)	-2.215^{*}	-4.375^{*}
f_{uet}	-2.693^{*}	(k=5)	-0.899^{*}	-8.388^{*}
f_{eut}	-2.720^{*}	(k=4)	0.368^{*}	-11.34^{*}
mm_t	-3.033	(k=4)	-3.989^{*}	-12.66^{*}

* unit root hypothesis not rejected at 5 percent significance.

† *ADF* stands for augmented Dickey-Fuller test. Cf. Dickey and Fuller (1981)

TABLE V.
Estimation and test results of wage curve equations for the Netherlands, with different measures of labour market tension.
Dependent variable: $\Delta \log w_t$.

constant	-.318	-.277	-.198	-.176	-.109	-.189
	(-2.037)	(-1.679)	(-1.246)	(-1.005)	(-0.705)	(-1.184)
$\Delta \log w_{t-1}$	-.357	-.382	-.378	-.375	-.397	-.401
	(-4.008)	(-3.803)	(-3.730)	(-3.662)	(-4.088)	(-4.201)
$\Delta \log p_{ct-1}$	.986	.633	.673	.547	.627	.586
	(4.677)	(3.584)	(3.784)	(3.050)	(3.674)	(3.480)
$\Delta \log p_{yt-1}$	-.239					
	(-2.336)					
$\Delta \log h_{t-3}$				1.05		
				(1.764)		
$\Delta \log tp_{t-3}$	.202	.162	.145	.103	.154	.176
	(5.169)	(3.262)	(2.997)	(1.856)	(3.326)	(3.703)
Δur_{t-2}	-1.44					
	(-4.361)					
Δmm_t				5.45		
				(1.451)		
Δf_{uet-2}					.907	.942
					(2.865)	(3.031)
$\log rwh^*_{t-1}$	-.071	-.088	-.073	-.065	-.055	-.070
	(-2.079)	(-2.521)	(-2.122)	(-1.700)	(-1.640)	(-2.067)
$\log p_{yt-1}$		-.027	-.029	-.026	-.030	-.028
		(-3.608)	(-3.873)	(-3.257)	(-4.252)	(-3.937)
ur_{t-1}	-.210					
	(-5.296)					
uv_{t-1}(*1000)		-.493		-.339		-.480
		(-2.794)		(-1.827)		(-2.868)
$stuv_{t-1}$(*1000)			-.679		-.623	
			-2.465)		(-2.359)	
R^2	.750	.698	.692	.717	.723	.732
$S.E.$	.0094	.0103	.0104	.0101	.0099	.0097
T	85	85	85	84	85	85
$F_{AR}(1,72)$	.065	.883	.796	.317	1.53	1.29
$F_{AR}(5,68)$	.486	.454	.426	1.03	.677	.683
$\chi^2_N(2)$	.258	.349	.542	.032	1.56	1.32
$F_{ARCH}(1,84)$	.133	.117	.143	.032	.313	.743
$F_{ARCH}(5,80)$	1.31	.105	.126	.322	.074	.170

* $\log rwh_t = \log w_t - \log p_{ct} - \log h_t$.

TABLE VI. Effects of a permanent increase in unemployment on wage growth for a number of quarters (q), in percentage points.

Effect after	1q.	2q.	3q.	4q.	5q.	6q.	7q.	8q.	12q.	16q.	20q.
Phillips curve:											
column (2)	.0	.0	-.12	-.23	-.34	-.46	-.33	-.21	.03	.02	.02
(5)	.0	-.03	-.05	-.07	-.11	-.09	-.06	-.03	.0	.0	.0
(6)	.0	-.10	-.11	-.12	-.12	-.03	-.03	-.02	-.02	- .02	-.02
wage curve:											
column (1)	.0	-.08	-.72	-.58	-.68	-.67	-.06	-.28	-.24	-.24	-.25
(5)	.0	-.02	-.26	.02	-.12	-.04	.18	-.09	-.01	-.01	-.01
(6)	.0	-.02	-.26	.04	-.10	-.04	.17	-.13	-.04	-.04	-.05

TABLE VII. Effects of a permanent decrease in vacancies on wage growth for a number of quarters (q), in percentage points.

Effect after	1q.	2q.	3q.	4q.	5q.	6q.	7q.	8q.	12q.	16q.	20q.
Phillips curve:											
column (2)	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
(5)	.0	-.07	-.11	-.23	-1.1	-1.3	-1.0	-.08	-.32	-.19	-.34
(6)	.0	.0	.04	.04	.04	.04	.0	.0	.0	.0	.0
wage curve:											
column (1)	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
(5)	.0	-.05	.04	-.20	-.77	-.79	-.64	-.43	-.18	-.12	-.24
(6)	.0	-.09	-.01	-.30	-1.2	-1.2	-1.0	-.70	-.28	-.19	-.38

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DATA APPENDIX: DEFINITIONS AND SOURCES

The quarterly data are mainly taken from the OECD, *Main Economic Indicators* (*MEI*). Yearly data, which were later interpolated were mainly obtained from the Dutch Central Planning Bureau (CPB), *Lange Reeksen* (*LR*). Interpolation was done by means of a third order polynomial function, cf. Hassink and Broersma (1993). The Dutch Central Bureau of Statistics is abbreviated to CBS.

w: index of hourly rates in manufacturing
source: OECD, *MEI*.

p_c: price index of total consumption
source: OECD, *MEI*.

p_y: price index of total output
source: OECD, *MEI*.

h: measure of labour productivity of the firm sector, based on a weighted average of actual labour productivity, with weights 0.3 in period t, 0.5 in period 0.5 in period $t-1$ and 0.2 in period $t-2$.
Interpolated.
source: CPB, *LR*.

tp: social premiums of employers and employees taken together, as percentage of gross wage costs of the firm sector. Interpolated.
source: CPB, *LR*.

ur: unemployment as percentage of the total labour force (=employment and unemployment)
source: OECD, *MEI*.

$stur$: unemployment rate with a duration shorter than one year, defined as $ur-ur4$, where $ur4$ is the unemployment rate with a duration longer than one year.
source: $ur4$: Ministry of Social Affairs and Employment.

vr: vacancies as percentage of total labour force. The data were taken from the OECD, *MEI*. To correct for the decline of the share of vacancies notified to the Public Employment Offices, we used corrected vacancy data for the eighties. These data are corrected using information from the CBS vacancy surveys. The CBS vacancy surveys are from October 1980, 1981, 1982, 1983, September 1984, January 1986, 1987, 1988. By interpolating, we calculated the average share of notified vacancies for the years 1980-1987. We assumed that for the period 1961-1979, this share was equal to the share of 1980.

F_{ue}: we used yearly data on vacancy flows to the Public Employment Office of the period 1971-1978 from Hartog (1980) to calculate average vacancy durations (duration = stock/flow). For 1980-1987, we used CBS vacancy survey data and applying the method described in van Ours and Ridder (1991). The average vacancy duration of 1979 by interpolating the yearly durations of 1978 and 1980. By interpolating the yearly data, we calculated quarterly duration data. Finally, we calculated vacancy flows as the quotient of vacancy stocks and vacancy durations. From 1987 to 1991, actual data on vacancy flows were obtained from the CBS, *Sociaal Economische Maandstatistiek.*

mm: defined as $|empmfg_t - empmfg_{t-1}|/emp$, where *emp* is total employment in thousand persons of wage earners and salaried employees. Yearly data from 1971–1987, are obtained from the OECD, *Labour Force Statistics.* Quarterly data from the CBS for 1984–1987 were used to determine quarterly fluctuations in employment. This quarterly pattern was then imposed on the yearly data. Data for 1988–1991 were directly observed from CBS, *Sociaal Economische Maandstatistiek. Empmfg* is the employment in the manufacturing sector, taken from the CBS, *National Account Statistics* and interpolated. Cf. Hassink and Broersma (1993).

F_{eu}: Flow of persons out of employment into unemployment, due to firing. Or the inflow of persons in unemployment insurance (WW). Interpolated source: Sociale Verzekeringsraad, *Kroniek van de sociale verzekeringen*, 1992.